NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

HIGH-TENSILE WIRE FENCE (NON-ELECTRIC)
(Feet)
CODE 382(b)

I. SCOPE

The work shall consist of furnishing materials and installing smooth wire at the location(s) shown on the plan map and, if needed, on the drawings or as staked in the field.

Fencing includes brace assemblies, gates, cattle guards, and other components required to meet site conditions and achieve objectives for practice application.

II. CONSIDERATIONS

Fence type and the fence design selected will be adequate to control the animal(s) of concern, must be suited to the landscapes over which it will be installed, and shall be adapted to the physical environment of the site. Fence type and the fence design selected will be adequate to meet the intended life expectancy of the conservation practice.

Boundary fences shall comply with Nevada state laws and fencing codes or standards for construction. Refer to the Nevada Revised Statutes Part 569.431 (1991) for the definition and requirements of a "Legal Fence".

WILDLIFE CONSIDERATIONS

High tensile wire fencing is not suited for areas where there are moderate numbers of deer, antelope, elk, or sage grouse. In areas of moderate wildlife use other fencing types/styles should be used to accommodate wildlife needs

Passage of big game animals over or under the fence line is a concern. There is also a strike concern for sage grouse and other large birds, the fence could pose an entanglement hazard for birds that are landing near the fence. When planning fences in known sage grouse habitat, consult with the NRCS State Biologist regarding the fence placement and lek locations.

Besides fence placement, there are a number of modifications that can be made to the fence to make it more visible to birds and other wildlife. To make a fence more visible, consider using the white tipped metal fence posts, securing flagging or reflectors to the top fence wires, or slide sections of PVC pipe over the top wire.

For additional wildlife friendly fencing information, refer to Fencing Guidelines for Wildlife (Wyoming Game and Fish, 2004) or A Landowner's Guide to Wildlife Friendly Fences (Paige, 2008).

III. SPECIFICATIONS

The wire itself is the unique difference in this fencing design. High-tensile wire fencing is constructed with six to ten (or more) line wires that are stretched to maintain as much as 300 pounds (or more) of tension.

A) MATERIALS

All fencing materials will be new, unless an exception is noted. ***All materials used in construction must be in accordance with the National Standard Material Specification NSMS #591 (National Engineering Handbook 2009) as described below:***

WIRE

Fencing materials shall conform to the requirements of American Society for Testing and Materials (ASTM) ASTM A854 for high-tensile wire.

When the size of steel wire is designated, the diameter shall be defined for U.S. Steel Wire Gage.

High-tensile, single strand, smooth wire shall be at least No. 12½-gauge (.099-inch diameter) steel wire.

All high-tensile smooth wire shall have a minimum strand tensile strength of 135,000-psi (at least 180,000-psi tensile strength wire is recommended).

All high tensile wire has ASTM Type I zinc protective coating.

The ASTM has graded metallic coated (galvanized), high tensile, steel fence wire as follows:

GRADE	MINIMUM TENSILE STRENGTH*	MINIMUM BREAKING POINT**
135	135,000	1,039
180	180,000	1,386
200	200,000	1,540
220	220,000	1,694

**pounds per square inch* (PSI)
***pounds of direct pull for No. 12½-gauge wire*

LINE POSTS

All wooden materials used in this practice that require preservative treatment will conform to National Standard Material Specification NSMS #585.

Round, pressure-treated, wooden posts work best for high tensile wire fencing. Wood posts need not be new material; however, all posts should be of the most durable wood type available, such as juniper, cedar, redwood, or eucalyptus. All posts that come in contact with the soil shall be treated with an EPA-registered wood preservative. Wood posts shall be treated from the butt end of the post to a distance of at least 30 inches for the line posts and 36 inches for all corner, gate, and brace posts.

Wood in-line posts shall be a minimum of 6½-feet in length.

The top of each wooden line post (2-inches above the top wire) shall be 3-inches, or larger, in diameter.

Standard T- or U-section steel posts (ASTM A702) weighing not less than 1.33-pounds per foot of length, exclusive of anchor plate, may be used in lieu of wooden line posts where post strength is not important, or in rocky areas where posts must be pounded or drilled to be set.

Steel line posts shall be at least 5½-feet long.

Steel line posts shall conform to the requirements of ASTM A702.

Steel posts are to be studded, embossed or punched for the attachment of wire and have an anchor plate near the bottom of the post. Steel line posts shall be rolled from high carbon steel and have a protective coating. The coating may be either galvanizing by the hot dip process or painted using one or more coats of high quality, weather resistant, paint or baked enamel.

Fiberglass posts are lighter than steel posts and withstand greater side-to-side stress. Polypropylene plastic posts have adequate strength but special clips are needed to attach wire to the posts. Fiberglass and plastic posts will not rot.

Fiberglass and plastic posts must be a minimum of 5½-feet long.

"T"-shaped fiberglass posts need to be at least 1¼-inch in diameter.

Round plastic posts should be at least 3⅜-inches in diameter.

Non-electric fencing should be grounded to reduce hazard from lightning. Spacing of grounding electrodes (*i.e.*, steel posts driven 3-feet into the ground) that have been connected to each line wire every 150-feet in a line of wood or fiberglass posts offers fair protection.

BRACE POSTS – WOODEN

All wooden materials used in this practice that require preservative treatment will conform to National Standard Material Specification NSMS #585.

- All wooden corner, gate, and in-line vertical brace unit posts shall have a minimum top diameter of 8-inches.
- Wooden corner, gate, and in-line vertical brace unit posts shall have a minimum length of 8-feet.
- Wooden horizontal or diagonal braces shall have a minimum diameter of 4-inches.
- Wooden horizontal braces shall be a minimum of 8-feet in length.
- Wooden diagonal braces shall be a minimum of 8½-feet in length.

Unless otherwise specified, wood brace posts shall be of cedar, redwood, juniper, or of other wood of equal life and strength. Pine posts treated with an EPA-registered wood preservative are acceptable.

BRACE POSTS – STEEL

Steel brace posts and horizontal braces shall conform to the requirements of ASTM A702 for steel posts and ASTM A53 for bracing pipes. Steel posts and braces shall have a protective coating; either galvanized, or painted using one or more coats of high grade, weather resistant, paint or baked enamel.

- All metal corner, gate and in-line vertical brace unit posts **(not Tee-posts)** shall at least 7½-feet in length.
- Steel pipe installed as posts shall have a minimum outside diameter (OD) of 4-inches.
- Horizontal or diagonal cross braces will be new or used pipe at least 3-inches (OD) diameter, or have an equivalent weight of 7.58-pounds per lineal foot.
- Steel horizontal braces will be a minimum of 7-feet in length.
- Steel diagonal cross braces will be a minimum of 7½-feet in length.

OTHER: Alternative types of materials and designs may be used for fence construction if: (1) they meet or exceed NRCS fence specifications; and, (2) they are approved in advance by the State Resource Conservationist.

BRACING WIRE

Brace wires (tension members or guy wires) shall be formed from two complete loops of No. 12½-gauge high tensile-galvanized wire, two complete loops of No.

9-gauge smooth wire, or two complete loops of No. 12½-gauge double strand smooth wire.

Tension wires shall have a tensile strength not less than 58,000 pounds per square inch and shall have a minimum of Class 3 zinc coating as specified in ASTM A641.

STAYS

Stays and stay fasteners shall conform to the requirements of the appropriate ASTM for the fencing material specified, unless otherwise specified.

- Wooden stays may be constructed of any sound, straight, piece of durable wood at least 1½-inches in diameter.
- Wooden stays should be long enough to extend at least 4-inches above the top wire strand.
- In areas of deep snow, wooden stays are preferable and should be at least 2½-inches thick by 3 inches wide.
- Wire stays shall have a minimum of Class 3 zinc coating as specified in ASTM A 641.
- Wire stays shall be at least No. 9½-gauge twisted wire especially manufactured for this purpose.
- Length of wire stays shall be at least 2-inches more than the distance between the top and bottom line wires. The lower part of wire stays shall not touch the ground.
- Wire stays are best suited for areas of only light snow pack, as heavy snow loads bend the wire stays and damage the fence.
- Fiberglass stays, especially fabricated for this purpose, may be used.

STAPLES AND CLIPS

Staples shall be No. 9-gauge galvanized wire at least 1¾-inches long.

Fence line wire shall be fastened to steel posts, fiberglass posts, or specially fabricated wooden posts using steel clips manufactured for this purpose or with two turns of No. 12½-gauge, high tensile, galvanized, wire.

B) CONSTRUCTION SPECIFICATIONS

ALIGNMENT

Fences shall be reasonably straight and not deviate more than 12-inches from a straight line between corner and brace assemblies. Reasonable deviations in alignment shall be permitted where rocky ground or steep slopes make it necessary.

FENCE HEIGHT

The intended use of the fence determines fence height and line wire spacing. The minimum height (measured from the ground line at post locations to the top line wire) of high tensile wire fences shall not be less than 36 inches. A minimum of 6 line wires shall be installed (Exhibit 1).

LINE POST

Line posts serve simply to maintain the spacing between wires and to set fence height.

- Wooden line posts shall be set solidly in the ground a minimum depth of 24-inches.

Wooden line posts can be driven.

Where post holes are dug for installing fence posts, the holes shall be at least 6-inches larger than the diameter or side dimension of the posts.

Post holes shall be back-filled with soil unless otherwise specified. Earth backfill around posts shall be thoroughly tamped and shall completely fill the post hole up to the ground surface.

- Steel or fiberglass line posts shall be driven solidly into the ground a minimum depth of 18-inches. Set steel posts at 24-inch depth in loose, sandy soils.

Under moderate snow-pack conditions, steel posts can be prevented from settling into the ground by attaching a wood stay to each steel post. If soil conditions prevent firmly setting line posts in the ground, rock-jacks or wire cribs may be used. See practice specifications for Rock-Jack and Figure-4 Fence, Practice Code 382(f).

LINE POST SPACING is the same for all line post materials (metal, wood, etc.): Line post intervals shall be as follows:

- 16½-feet (1 rod) maximum line post interval *without* stays.
- 20-foot maximum line post interval when *one stay* is set mid-way between line posts.
- 30-foot maximum line post spacing when *two stays* are set at 10-foot intervals between posts.

In heavy snow country, wooden posts should be spaced at no more than 16½-foot (1 rod) intervals to assure strength.

In very loose, sandy, soils, line posts may need to be spaced as close as 10-feet apart.

LINE WIRE INSTALLATION

Fence line wires shall be stretched and attached to posts as follows:

- The fencing wire shall be placed on the side of the post expected to receive the greatest pressure.
- Where fencing is installed to protect a specific area, wire shall be placed opposite the area being protected.

- For installation along curved sections, fencing wire shall be placed on the outside of posts forming the curve.
- The top line wire shall be set so that fence posts extend a minimum of 2-inches above the wire.
- The fencing wire shall be fastened to conventional wooden line posts using 1¾-inch long steel staples driven diagonally with the grain of wood. Each strand of wire shall be attached to each post. (Exhibit 3).

The fencing wire shall be fastened to specially fabricated wooden line posts, fiberglass line posts, or to standard T- or U- steel line posts by means of steel wire clips manufactured for this purpose; or with two turns of No. 12½-gauge high tensile, galvanized, wire. Each strand of wire shall be attached to each post.

- Line wires must be free to move back and forth through staples or other types of wire fasteners.
- All line wires shall be dead-ended on the anchor post (pull post) of gate, corner, and in-line brace assemblies (Exhibit 1).

WIRE SPACING

Wire spacing should be varied according to need.

Examples of fence height and wire spacing (from the ground upward) for a high-tensile fence to control:

MATURE CATTLE and CALVES - NO SHEEP
BOUNDARY FENCE
8-wire fence: 6" - 11" - 16" - 21" - 27" - 33" - 40" - 48"
DRIFT/DIVISION FENCE
6-wire fence: 14" - 19" - 25" - 31" - 38" - 46"
MATURE CATTLE with/without CALVES AND SHEEP
8-wire fence: 4" - 9" - 14" - 19" - 25" - 31" - 38" - 46"
10-wire fence: 4"-8"-12"-16"-21"-26"-31"-36"-41"-46"
SHEEP
7-wire fence: 5" - 10" - 15" - 20" - 25" - 30" - 36"

FENCE WIRE TENSION - Exhibit 2

- Line wire strainers (ratchet wire tighteners) shall be attached to one end of each line wire.
- Each line wire strand is stretched taut to 250 to over 300-pounds of tension depending on wire grade. For wire below 200,000 psi tensile strength, a 250-pound per strand of wire tension is recommended.

A tension indicator spring can be installed on one line wire and remaining wires tightened, according to feel, to same tension as the wire strand with the indicator spring.

On long, straight, fence runs over 600-ft in length, wire tighteners should be installed at the center point (friction center) between fence ends.

Keep high-tensile wires tightened to the recommended tension. In areas of extreme temperature fluctuation, reduce wire tension at the onset of cold weather and restore tension to the correct tension in the spring.

STAYS

When required, stays shall be evenly spaced between line posts to ensure that the proper interval between line wire strands is maintained.

SPLICING

When splicing line wires, the "Figure-8" knot or suitable splice sleeves applied with a tool designed for that purpose shall be used.

The "Figure-8" knot shall have no less than four (4) wraps of each end about the other. All wraps shall be tightly wound and closely spaced (Exhibit 3).

Splices made with splice sleeves shall have a tensile strength no less than 80 percent of the strength of the wire being spliced.

CORNER, BRACE, AND GATE POSTS

Braces are required at all corners, gates, and at all definite slope breaks and changes in alignment to the line fence.

- In straight sections on moderate terrain, in-line brace units are required at intervals not to exceed 2640 feet (160 rods). (Exhibit 1).
- Corner brace assemblies shall be installed at all points where the fence alignment changes 15-degrees or more. Brace units are required at the beginning and end of each curved fence section.
- Brace units are required at any point where the vertical angle described by two adjacent reaches of wire is upward and exceeds 10-degrees.

If soil conditions prevent the proper setting of anchor posts and brace posts in the ground, rock-jacks or wire cribs may be used. See practice specifications for Rock-Jack and Figure-4 Fence, Practice Code 382(f).

- All wooden corner, gate, and in-line brace unit posts shall be set a minimum of 4-feet in the ground - the deeper a post is set, the stronger it will be.
- Anchor posts (pull-posts) shall be set with a I.0 to 2-inch lean away from the direction of fence pull. See Exhibit 1.

Wooden brace posts can be driven.

If post holes are dug for installing fence posts, the holes shall be at least 6-inches larger than the diameter or side dimension of the posts. Post holes are to be back-filled with soil unless otherwise specified. Earth backfill around posts shall be tamped and completely fill the post hole to the ground surface.

- Metal corner, gate, and in-line brace assembly posts shall be set in concrete a minimum of 3½-feet in the ground.

Concrete backfill around posts shall be rodded into place in layers not thicker than 12-inches and shall completely fill the post hole to the surface of the ground. Backfill, either soil or concrete, shall be crowned-up around posts at the ground surface. No stress shall be applied to posts set in concrete for a period of not less than 24-hours following the development of a firm set of the concrete.

Wooden, horizontal, brace members (compression braces) shall be notched into the top part of the brace post and post being braced, at a location between the top two line wires. Steel dowels can be used, rather than notching, to attach a horizontal brace between the anchor post and brace post.

The elevated end of diagonal brace members shall be notched into post being braced at a location sited between the top two line wires.

BRACING WIRE

Brace wiring (tension member) shall consist of two (2) wire strands that extend from a point approximately 6-inches below the top of the brace post to about 4-inches above the ground level of the post being braced (anchor post or pull post). The brace wires should be double wrapped around each post, stapled, and spliced together. A stout stick, pipe, or metal rod, about 18 to 24-inches long, is placed mid-way along the brace wires, and all four wires are twisted together so the brace wires tightly secure the compression brace and provide needed rigidity. If a diagonal brace is used, the tightening stick is positioned below the diagonal to avoid hitting this brace member as the stick is turned (Exhibit 1).

GATES

Materials used in construction of wire gates shall conform to the kinds, grades, and sizes specified for a new fence, and shall include the necessary fittings and stays.

Panel gate fittings shall not be of a lesser quality than the gate manufacturer's standard.

IV. INSTALLATION

Installation of the fence shall conform to the specifications and exhibits or other drawings, as provided.

All posts shall be placed to the required depth and shall be firmly embedded so that there is less than 1-inch of horizontal movement at the top of post when a horizontal force of 80-pounds is applied.

V.BASIS OF ACCEPTANCE

After the fence has been installed, a site inspection will be made to determine if fence construction, and the materials used, meets practice specification requirements.

VI. MAINTENANCE

This practice will require the performance of periodic maintenance.

Fence maintenance items to be alert to and corrected include:

- tension of wire
- broken wires
- wire corrosion
- pulled staples or clips
- bent steel posts
- bent or broken stays
- post alignment
- post stability
- sagging gates
- wildlife concerns

REFERENCES

The following references provide excellent guidance for fence construction, selection of fencing materials, and the installation of fence components.

Paige, C. 2008. A Landowner's Guide to Wildlife Friendly Fences. Landowner/Wildlife Resource Program, Montana Fish, Wildlife, and Parks. Helena, MT. 44 pp.

Planning Fences. 1980. American Association for Vocational Instructional Materials Eds.

Sanderson, H.R. T.M. Quigley, E.E. Swan, L.R. Spink, 1990. Specifications for Structural Range Improvements. Gen. Tech. Rep. PNW-GTR-250. Portland, OR. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 126p.

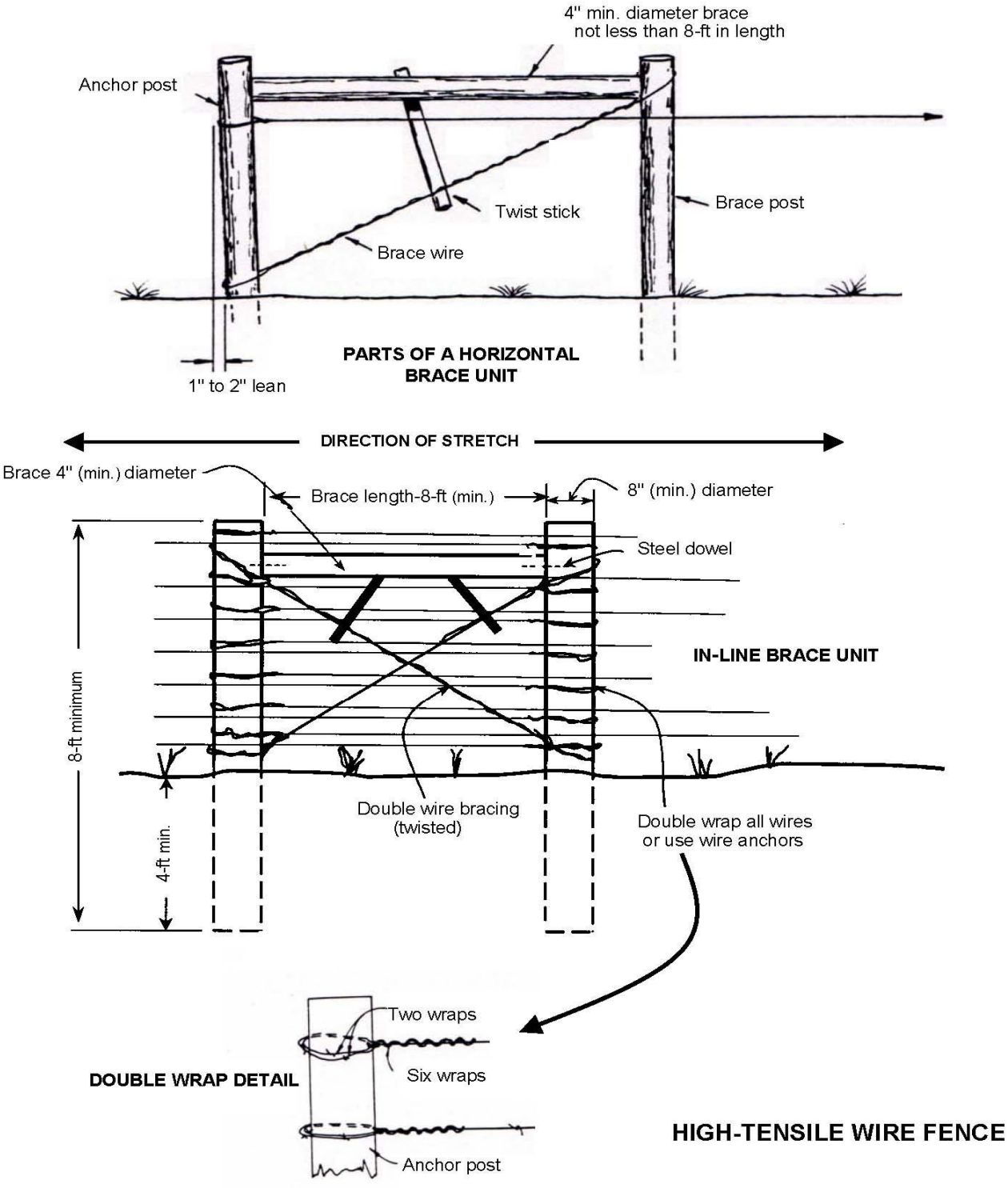
Selders, A.W. and J.B. NcAninch. 1987. High-Tensile Wire Fencing. Natural Resource, Agricultural & Engineering Service.

USDA Natural Resources Conservation Service. 2009. National Engineering Handbook Part 642.

USDI Bureau of Land Management and USDA Forest Service. 1988. Fencing. 2400-Range 8824 2803.

Wyoming Game and Fish Department. 2004. Fencing Guidelines for Wildlife. Habitat Extension Bulletin No. 53.

EXHBIT 1

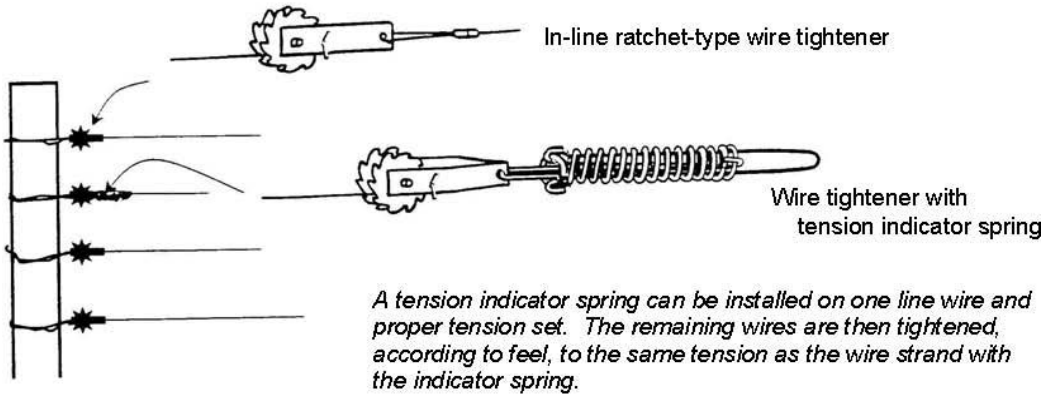


After Sanderson et al (1990) and USDI/USFS 2400-Range 8824 2803 (1988)

EXHIBIT 2

Measuring Wire Tension

Several wire tensioning tools are available, including tension indicator springs that measure wire tension or that allow tensioning line wires to a preset number of pounds.



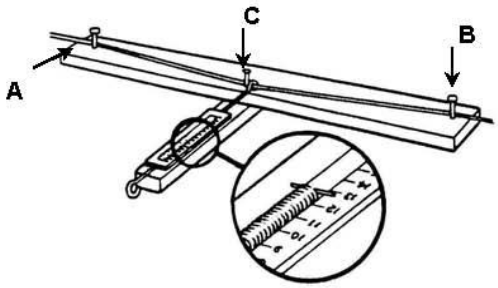
A tension indicator spring can be installed on one line wire and proper tension set. The remaining wires are then tightened, according to feel, to the same tension as the wire strand with the indicator spring.

A simple device can also be fabricated that adequately measures wire tension. On a straight piece of 1-inch x 4-inch board that is 44-inches long, drive two cup hooks (or nails) 40-inches apart and one-inch down from the top of the board (points A and B in the drawing below). Drive a nail ½-inch below the center point of the straight line from point A to B (this is point C in the figure below). Place a fence line wire on the cup hooks (or nails) at points A and B. Attach a spring scale to the center of the line wire and pull the scale until the wire touches the nail at point C. Read the number of pounds needed to pull the wire to point C and multiply by 20 to determine pounds of line tension.

For example, a pull of 12½-pounds times 20 equals a tension of 250 pounds on the line wire.

Construction of this simple tension meter is based on the general formula for static wire tension:

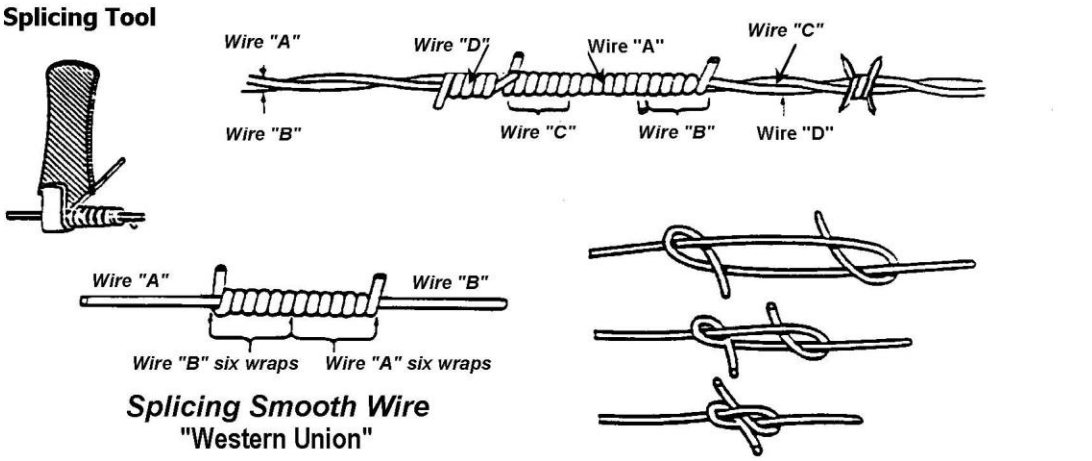
$$\text{Tension (pounds)} = \frac{\text{Length (inches)} \times \text{Balance Scale Reading (pounds)}}{4 \times \text{Vertical Displacement (inches}}$$



after Sanderson et al (1990) and USDI/USFS 2400-Range 8824 2803 (1988)

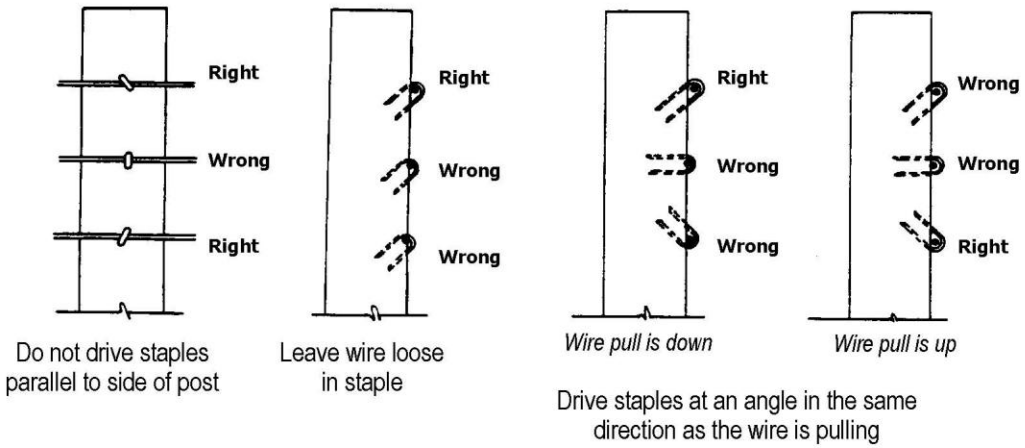
EXHIBIT 3

Splicing Barbed Wire



In-Line Splicing by Tying a "Figure-8" Knot

Stapling Wire to Wooden Posts



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